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Economic Activity Associated With the Garrison Diversion Unit in 1984

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TABLE OF CONTENTS

Tables

Figures

Highlights

This report estimates the gains and losses experienced by North Dakotans resulting from inundation of over 500 thousand acres of land by two Missouri River reservoirs and evaluates the potential economic effect of diverting Missouri River waters for irrigation.

Although some compensation was made to North Dakota in the form of payments to landowners, electric power generation, flood control, and recreation benefits, North Dakota experiences annual agricultural losses of $131 million in gross business volume (GBV) and $45 million in personal income (PI) due to inundation from Garrison and Oahe reservoirs. In addition, annual losses due to bank erosion in 1984 were estimated at $614,000 in GBV and $196,000 in PI. Almost $3.5 million worth of cottonwood stumpage sales were lost, which would have produced over $21 million worth of lumber sales from sawmills.

Differential income flows were estimated for irrigated and dry cropland. Results of input-output analysis indicate that the increase in agricultural production brought about by the authorized 250,000-acre irrigation project would increase annual GBV by $153 million and annual PI by $50 million. This economic activity represents a net annual gain over inundation losses of $22 million in GBV and $5 million in PI. An 85,510-acre alternative project would increase annual GBV by $55 million and annual PI by $19 million, but would not adequately compensate for inundation losses.

A one-year delay in project completion from the year 1984 would result in a present value of $10 million in GBV and $3.3 million in PI foregone in North Dakota.

ECONOMIC ACTIVITY ASSOCIATED WITH THE GARRISON DIVERSION UNIT IN 1984

Jay A. Leitch and LeRoy W. Schaffner*

Background

Authorized by the U.S. Congress in 1965, North Dakota's Garrison Diversion Unit (GDU) has come under continual criticism by environmental organizations and the Canadian government. These criticisms, resulting lawsuits, and political pressure have delayed and threatened to halt the GDU. The merits of the project notwithstanding, the economy of the State of North Dakota has been affected by project delays and stands to forego substantial economic activity if the project is shelved.

The purpose of this report is to estimate the impacts of inundation, project delays, and potential abandonment on economic activity within the state.[1] Thus, value estimates are made from a statewide perspective and are not construed to have any relationship to nationwide benefit-cost accounting.

Procedures

Secondary economic activity and employment effects of North Dakota's Missouri River reservoirs and the Garrison Diversion Unit were estimated using input-output analysis. With the exception of including employment opportunities foregone, procedures were similar to Leitch and Anderson (1978). The primary difference is in use of current data, such as budgets, crop prices, and construction schedules.

Three GDU scenarios are developed. Scenario I depicts gross business volumes, personal income, and employment that would be supported by operation of the 250,000-acre Garrison Diversion Unit. Scenario II depicts those activities associated with an 85,510-acre alternative as presented in Wright Water Engineers, Inc. (1983). Scenario III replicates the impacts of delays in the 250,000-acre project as estimated by Leitch and Anderson (1978).

Inundated Lands

Economic activity on inundated lands was estimated by first developing budgets according to potential land uses. Second, an input-output model was used to estimate economic activity associated with budget expenditures in each of four sectors of the North Dakota economy. These four sectors were (1)

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[1]This report is an update of Jay A. Leitch and Donald E. Anderson, Impact of Inundation and Changes in Garrison Diversion Project Plans on the North Dakota Economy, Agricultural Economics Report No. 127, Department of Agricultural Economics, North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, March 1978. Research was supported by the North Dakota Agricultural Experiment Station and a grant from the Garrison Diversion Conservancy District.

retail trade, (2) business and personal services, (3) finance, insurance, and real estate, and (4) households (Appendix A). The input-output model estimates both gross business volume and personal income. Finally, gross business volume to employment ratios by state planning region were used to estimate the amount of employment that would be supported by the gross business volumes generated.

Irrigation Project Lands

Economic activity on Garrison Diversion Unit lands was estimated as the effect the additional dollar flows of irrigated versus dryland farming would have on gross business volumes, personal incomes, and employment. Data sources are as noted on appropriate tables, referenced in the text, or as found in Leitch and Anderson (1978). Prices used in this updated analysis were long-run (1974-1983) average prices for North Dakota (Table 1). Crop rotation areas are the same as Leitch and Anderson (1978) (Figure 1).

TABLE 1. LONG-TERM CROP PRICES, 1974-1983 AVERAGE

Crop	Price
Wheat	$ 3.49 bu
Barley, All	2.22 bu
Oats	1.32 bu
Corn	2.50 bu
Flax	6.52 bu
Rye	2.17 bu
Soybeans	6.22 bu
Field Beans	17.75 cwt
Sunflower	10.95 cwt
Potatoes	3.91 cwt
Sugarbeets	29.75 ton
Alfalfa Hay	49.65 ton
Corn Silage	16.38 ton
Native Hay	34.75 ton
Tame Hay	44.70 ton

SOURCE: North Dakota Agricultural Statistics (annual).

Inundation Losses

Two reservoirs were created on the Missouri River in North Dakota as part of the Pick-Sloan Plan[2] for development of Missouri River Basin water resources. Lake Sakakawea, formed as a result of Garrison Dam approximately 70

[2]Flood Control Act of 1944 (57 Stat. 877).

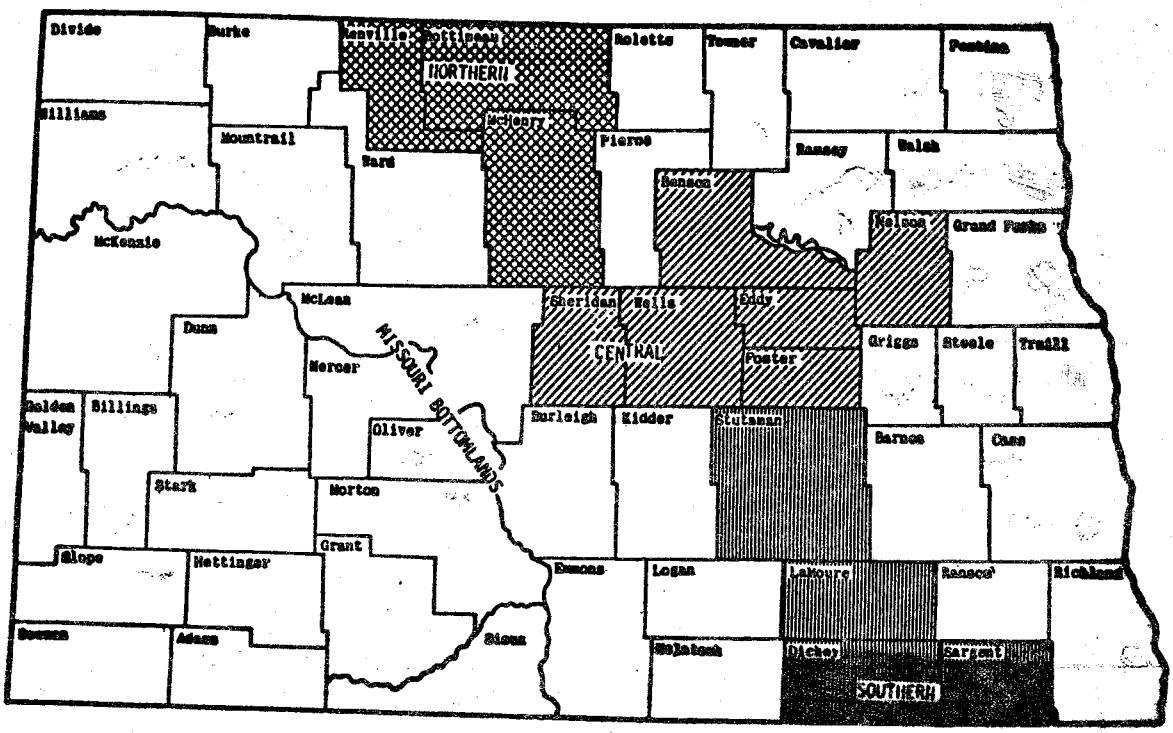

Figure 1. Crop Rotation Areas/Study Areas

miles north of Bismarck, North Dakota, inundated over 460,000 acres in six counties. Lake Oahe, formed as a result of Oahe Dam near Pierre, South Dakota, inundated over 100,000 acres in North Dakota.

Adverse effects of reservoirs have been discussed in the past (Great Plains Council, 1952). The impacts of inundation on the North Dakota economy were first discussed by Johnson and Goodman (1962), again by Leitch and Anderson (1978), and will be reviewed and expressed in 1984 dollars in this report.

Garrison Reservoir Losses

Real or potential changes in economic activity were brought about in agriculture, mining, and forestry, and as a result of bank erosion.

Agricultural Impacts

Missouri River bottomlands, which made up a large portion of land inundated, were integral parts of farming operations. Some of the land was being dryland farmed, some irrigated, and some pastured. There was potential to intensify agricultural uses of river bottomlands, especially to increase the number of acres irrigated.

Land use changes as reported by Leitch and Anderson (1978) were evaluated using 1983/84 crop budgets (Appendix B). The 462,962 acres inundated by Garrison Dam would have generated $37 million of personal income to North Dakotans and $109 million of gross business volume in 1984 (Table 2).

TABLE 2. LAND USE AT TIME OF TAKING, PRESENT POTENTIAL LAND USE, AND FOREGONE ANNUAL ECONOMIC ACTIVITY, GARRISON RESERVOIR, 1984 DOLLARS

Land Use	Total at Time of Taking[a]	Potential Use in 1984	1984[b] Personal Income	1984[b] Gross Business Volume	1984[b] Employment
	----------acres----------		---------dollars----------		
Woodland	88,001	68,545	c	c	c
Pasture	196,914	163,556	5,626,326	12,479,323	180
Dryland Cropland	169,580	128,536	10,366,428	29,812,640	975
Irrigated Cropland	7,966	79,101	21,228,335	66,308,786	1,158
Urban	500	0	NA	NA	NA
Other	0	500	0	0	0
TOTALS	462,962	462,962	37,221,089	108,600,749	2,313

[a]Leitch and Anderson 1978.
[b]See Appendix B.
[c]Timber harvest is a one-time activity; therefore, no long-term economic activity is created.

Mineral Losses[3]

Garrison Reservoir inundated areas of the Fort Union coal formation, and Oahe Reservoir inundated areas of Hell Creek and Fox Hills coal formations in North Dakota. An estimated 5,850 million tons of lignite were inundated by Garrison Reservoir. In addition to lignite, there are 29 potential 80-acre petroleum locations within the 1,850-foot contour limits of Garrison Reservoir. If all proved to be productive, they would yield an estimated 5 million barrels of oil. Whether these mineral resources would have been developed and to what extent is academic; the point is that their use was lost to the North Dakota economy.

[3]From Leitch and Anderson (p. 12, 1978).

Forestry Losses

The estimated 1984 market value of cottonwood stumpage lying below the taking elevation is $3.5 million. This assumes a harvest of 20 percent of the potential 508 million board feet (Leitch and Anderson 1978). Landowners would have received approximately $32 per thousand board feet, a total of $3.5 million, while the value of lumber produced at a sawmill would have been $190 per thousand board feet--a total of $21 million.

Bank Erosion Losses

Total acreage lost to Missouri River bank erosion between Garrison Dam and Lake Oahe through 1983 was 2,447 acres. Assuming 28 percent was dryland cropland, 17 percent was potentially irrigated cropland, 35 percent pasture, 15 percent woodland, and 5 percent other nonincome producing would result in $614,514 in gross business volume and $196,333 in personal income foregone in 1984 (Table 3).

TABLE 3. ESTIMATED TOTAL MISSOURI RIVER BANK EROSION LOSSES IN NORTH DAKOTA THROUGH 1983

Land Use	Acres	GBV	PI	Employment
Dry Crop	685	$158,878	$ 55,245	2
Irrigated Crop	416	390,324	111,642	6
Pasture	856	65,312	29,446	1
Woodland	367	--	--	-
Other	123	0	0	0
Total	2,447	$614,514	$196,333	9

Oahe Reservoir Losses

If a similar estimation procedure as for Garrison is used, the annual Oahe Reservoir losses in 1984 are estimated to be $22.4 million in GBV, including $7.8 million in personal income, and 328 jobs (Table 4).

Secondary Economic Effects

250,000-Acre GDU

The 250,000 acre area as identified by "Garrison Diversion Unit Special Project Study" was used for this analysis (Bureau of Reclamation 1977). It

TABLE 4. LAND USE AT TIME OF TAKING, PRESENT POTENTIAL LAND USE, AND FOREGONE ANNUAL ECONOMIC ACTIVITY, OAHE RESERVOIR (NORTH DAKOTA), 1984 DOLLARS

Land Use	Total at Time of Taking	Potential Use in 1984	1984 Personal Income	1984 Gross Business Volume	1984 Employment
Woodland	106,389	12,190	--	--	--
Pasture	62,256	48,161	$1,656,738	$ 3,674,684	66
Dryland Cropland	29,096	25,376	2,046,574	5,885,709	37
Irrigated Cropland	0	15,342	4,117,332	12,860,892	225
Urban	0	0	NA	NA	NA
Other	0	5,320	0	0	0
Total	106,389	106,389	$7,820,644	$22,421,285	328

includes 116,000 acres in the northern area, 74,670 acres in the central area, and 59,993 acres in the southern area (Figure 1).

Land would be taken out of production for construction of project features such as canals and reservoirs. Lands taken for wildlife mitigation are not analyzed since they have not been identified and land use would probably not change substantially on the majority of them; only ownership would be affected. The project features for 250,000 acres of irrigation would change the land use on approximately 54,325 acres, of which about one-half is currently being cropped (Table 5). Lands taken out of production for project features would result in $4 million lost annually in gross business volume, $1.1 million in lost personal income, and 47 jobs lost.

Assuming the entire 250,000-acre GDU were operational in 1984,[4] a total additional gross business volume of $153 million would occur in North Dakota (Table 6). Increased personal income would account for $50 million of this

[4]The assumption of the entire project having been operational in 1984 is presented merely to show the influence of irrigation relative to current values, as opposed to presenting the influence of the entire project life and discounting to present. By using 1984 as a hypothetical case some of the abstract concepts, such as discounting and project life, can be avoided.

TABLE 5. 250,000-ACRE GDU PROJECT FEATURE LAND USE BEFORE DEVELOPMENT, 1984 LOSSES

Land Use	Acres	GBV	PI	Employment[a]
Cropland[b]	30,500	$3,695,075	$ 932,080	41
Range[c]	16,495	314,642	141,857	6
Woodland	585	d	d	d
Water & Other	6,895	NA	NA	NA
Total	54,325	$4,009,717	$1,073,937	47

[a]Productivity ratios for SR2 were used (Appendix Table A2).
[b]Cropland dollar flows were assumed to be equivalent to GDU central area dryland (Appendix Tables D1 and D5).
[c]Rangeland dollar flows were assumed to be 1/4 of inundated land pasture dollar flows (Appendix Table B5).
[d]Woodland would have remained as woodland and not generated significant economic activity.

amount of gross business volume, and employment for 3,410 people would be supported by this economic activity.[5]

85,510-Acre Alternative

An 85,510-acre alternative Garrison irrigation project would generate $54.6 million in gross business volume, including $18.5 million in personal income (Table 7). An additional 1,050 jobs would be supported by this economic activity in North Dakota.

One-Year Delay in 250,000-Acre GDU[6]

The amount of gross business volume and personal income foregone as a result of delays in constructing the Garrison Diversion Unit is equal to the present value of each year of delay less the present value of each additional year of project life. For example, the present value of a dollar to be

[5]There may be surplus labor or underemployment without the project. Thus, 3,410 new jobs may not be created, but there would be reductions in both unemployment and underemployment.

[6]A one-year delay implys shifting each element of the project ahead to a later year. In other words, the West Oakes segment scheduled for completion in 1986 would be hypothetically shifted ahead to 1987, likewise for the other project segments.

TABLE 6. ANNUAL ADDITIONAL GBV, PERSONAL INCOME, AND EMPLOYMENT AS A RESULT OF A 250,000-ACRE GDU PROJECT, 1984 DOLLARS

Item	Project Area			Totals
	Southern	Central	Northern	
Acres Irrigated	59,330	74,670	116,000	250,000
Gross Business Volumes				
Per Acre	$ 793.39	$ 600.05	$ 560.31	---
Aggregate	$47,071,829	$44,805,734	$64,995,960	$156,870,000
Lost to Features	---	---	---	-3,695,075
Net Change in GBV	---	---	---	$153,174,925
Personal Income				
Per Acre	$ 262.16	$ 194.72	$ 180.42	---
Aggregate	$15,553,953	$14,539,742	$20,928,720	$ 51,022,415
Lost to Features	---	---	---	-1,073,937
Net Change in PI	---	---	---	$ 49,948,478
Employment				
Aggregate	863	833	1,725	3,457
Lost to Features	---	---	---	47
Net Employment Change	---	---	---	3,410

received five years from today discounted at 7 percent[7] is 71 cents. The present value of a dollar to be received 50 years from today is only 3 cents. By foregoing receipt of a dollar in five years for a dollar in 50 years, a present value loss of 68 cents occurs.

Given the water delivery schedule in Table 8 and the income differentials in the previous section, the present value of personal income foregone due to one year's project delay is $3.3 million. The present value of gross business volume foregone due to a one-year delay would be about $10 million (Table 9).

Summary

Comparing levels of economic activity (GBV and PI) and employment foregone due to inundation by Missouri River reservoirs within North Dakota to economic activity with two alternative Garrison irrigation projects shows one to leave North Dakota ahead and the other to make the state a net loser (Table

[7]Seven percent was arbitrarily selected as a reasonable discount factor.

TABLE 7. ANNUAL ADDITIONAL GBV, PERSONAL INCOME, AND EMPLOYMENT AS A RESULT OF A 85,510-ACRE ALTERNATIVE GARRISON PROJECT, 1984 DOLLARS

Item	Project Area[a] Southern	Central	Totals
Acres Irrigated	33,010	52,500	85,510
Gross Business Volumes			
Per Acre	$ 739.39	$ 600.05	---
Aggregate	$24,407,264	$31,502,625	$55,909,889
Lost to Features[b]	---	---	-1,256,325
Net Change in GBV	---	---	$54,653,564
Personal Income			
Per Acre	$ 262.16	$ 194.72	---
Aggregate	$ 8,653,902	$10,222,800	$18,876,702
Lost to Features[b]	---	---	-365,139
Net Change in PI	---	---	$18,511,563
Employment			
Aggregate	480	586	1,066
Lost to Features[b]	---	---	16
Net Employment Change	---	---	1,050

[a]While project areas are not precisely the same as Phase I of the 250,000-acre GDU, they fall within the same general geographic area. See Table 6 and Figures 2 and 3.
[b]The loss to features is a percentage (34 percent) of the loss of the 250,000-acre GDU.

10). The state would stand to gain $22 million annually over and above reservoir losses if the 250,000-acre project were in place in 1984. On the other hand, a net annual loss of $76 million would occur if the 85,510-acre alternative were in place. As it stands, with no irrigation project in operation, annual losses have no offsetting gains in economic activity.

A one-year delay in the project schedule would mean foregone gross business volumes of $10 million, including $3.3 million in personal income.

Other Factors

Clearly, there is much more to the GDU issue than presented here. However, from the perspective of North Dakota business activity, the salient issues have been addressed. Other factors include compensation for lands inundated, electric power generation, flood control values, recreation, and municipal and industrial use of GDU water.

TABLE 8. WATER DELIVERY SCHEDULE FOR 250,000-ACRE GDU AND 85,510-ACRE ALTERNATIVE

Area	250,000-Acre GDU Acres Irrigated/Year		85,510-Acre Alternative[a] Acres Irrigated/Year	
Phase I				
Southern:				
	5,000	1986	5,000	1986
West Oakes	7,000	1989	7,000	1989
	7,660	1990	7,660	1990
LaMoure	13,350	1989	13,350	1989
	33,010		33,010	
Central:				
Lincoln Valley	6,515	1989	--	--
New Rockford	20,935	1990	--	--
New Rockford Extension	--	--	18,000	1993
Warwick-McVille	25,000	1993	--	--
Turtle Lake	--	--	8,500	1989
Harvey	--	--	2,000	1989
Sykeston	--	--	10,000	1989
McClusky Canal	2,000	1985	7,000	1985
	54,450		52,500	1987
	87,460		85,510	
Phase II[b]				
Southern:				
	8,774	1994	--	--
East Oakes	8,773	1995	--	--
	8,773	1996	--	--
Central:				
	7,407	1994	--	--
Warwick-McVille	7,407	1995	--	--
	7,406	1996	--	--
Northern:				
Karlsruhe	12,200	2000	--	--
Middle Souris	103,800	2000	--	--
			85,510	
	252,000[c]			

[a]Wright Water Engineers (1983) Alternative Plan. Water delivery dates are estimates.
[b]Hudson Bay Drainage. Water delivery no earlier than 1994.
[c]Includes 2,000 acres adjacent to McClusky Canal to be irrigated in 1985.

TABLE 9. GROSS BUSINESS VOLUME AND PERSONAL INCOME FOREGONE DUE TO DELAY OF 250,000-ACRE GDU, 1984 DISCOUNTED PRESENT VALUE

Years of Delay[a]	Gross Business Volume Foregone	Personal Income Foregone
1	$ 9,795,000	$3,300,000
2	14,617,000	4,824,000
3	19,033,000	6,281,000
4	23,153,000	7,640,000
5	27,573,000	9,099,000

[a]Years of delay assumes water delivery for every acre of the GDU is delayed by the number of years indicated.

TABLE 10. COMPARISON OF INUNDATION LOSSES AND POTENTIAL GAINS TO GARRISON IRRIGATION ALTERNATIVES

Item	Foregone Due to Missouri River Reservoirs	Gains with GDU Project(s)	Net
GBV	$108,600,749 (Garrison) 22,421,285 (Oahe) $131,022,034	250,000-Acres $153,174,925	+$22,152,891
		85,510-Acres $ 54,653,564	-$76,368,470
PI	$37,221,089 (Garrison) 7,820,644 (Oahe) $45,041,733	250,000-Acres $49,948,478	+$ 4,906,745
		85,510 Acres $18,511,563	-$26,530,170
Employment	2,313 (Garrison) 328 (Oahe) 2,641	250,000 Acres 3,410	+769
		85,510 Acres 1,050	-1,591

Compensation to North Dakota

The federal government compensated landowners for the 570,000 acres of land taken. Also, North Dakota expected to benefit from the two reservoirs and operation of the power plant at Garrison Dam. Electrical power, flood control, and recreation were all part of the benefits the state expected to receive in addition to payments made to landowners. Most importantly, North Dakota expected to complete the Garrison Diversion Unit, an irrigation project for up to 1,000,000 acres of arid cropland.

Adequate compensation cannot always be determined or made when large-scale development forces hundreds of landowners to sell all or part of their farming operation. Leitch and Anderson (1978) discuss the problems associated with these land sales.

A cursory review of payments made for land taken for Garrison and Oahe reservoirs shows that payments of $21 million were made for Garrison Reservoir and $7.7 million for Oahe Reservoir in North Dakota (Leitch and Anderson 1978). If the average payment of $46.27 for Garrison and $96.57 for Oahe were adjusted at a 7 percent rate of appreciation to 1982, the resulting values would be $349 and $346, respectively. The average value for farmland and buildings in Oliver, Morton, McLean, Burleigh, Emmons, Mountrail, and McKenzie counties in 1982 was $309.[8] In other words, with a land value appreciation rate of 7 percent, payments to landowners for land taken for the reservoirs were close to 1982 land values in those areas inundated. These payments do not entirely make up for the loss in business volumes generated as a result of operating the farmland inundated, because much of these proceeds was probably reinvested out of state.

Electric Power Generation

The five turbine-generators located in the Garrison Dam powerhouse have a combined capacity of 400,000 kilowatts and are capable of producing over 2 billion kilowatt-hours of electrical energy annually. The first generator was activated in 1956. Through December 1983, the project had produced about 60 billion kilowatt-hours of electrical energy. North Dakota consumers have been receiving from one-third to one-half of the electrical energy produced at Garrison Dam.

Flood Control

Flood control benefits of Garrison Dam are realized primarily by residents of downstream states. It is assumed that very little is accounted for in North Dakota because the river bottoms were not extensively developed prior to construction of the dam. Floods that did occur were as much a benefit to farmland as they were a detriment in that they provided valuable soil moisture and deposited rich sediment upon the land.

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[8] 1982 Census of Agriculture.

Recreation

North Dakota traded one form of recreation for another. The recreation provided by 295 miles of free flowing river and several hundred thousand acres of choice river bottom habitat was traded away for over 500,000 acres of slack water, namely Lakes Sakakawea and Oahe. The creation of Lake Sakakawea tripled the total fishing water in the state.

While there is no doubt that developent of Lake Sakakawea and Oahe Reservoir provide substantial recreational opportunities to the state of North Dakota, these opportunities were gained only with the loss of other types of recreational opportunities. Whether the state was a net gainer or loser in terms of recreational opportunities remains an open question.

Maintenance of water in Devils Lake is a proposed feature of the authorized 250,000-acre GDU. Devils Lake has a history of boom and bust fishing. It is currently experiencing a boom with anglers spending millions of dollars annually in the region (Schwinden and Leitch 1984).

Municipal and Industrial Use of GDU Water

Water supply for domestic, municipal, and industrial uses has been a component of multiple-use plans for the Missouri since those plans began to take shape in the 1940s. The Bureau's original plan for the Missouri in North Dakota (Senate Document 191) included water supply to 19 municipalities.

Twenty-nine municipalities would be served with Missouri River water with the full development plan for Garrison Diversion (Table 11). Several other municipalities may likely request diversion waters when the unit is completed, once they are sure of the supply and have some idea of the cost of GDU water and the cost of water from alternative sources.

Summary

This study was designed to measure the annual impact of Missouri River development programs on the economy of the state of North Dakota by providing estimates of the economic losses due to inundation by the Garrison and Oahe Reservoirs and potential economic gains due to irrigation under the Garrison Diversion Project in the state of North Dakota. The reader should recognize that all expenses and income flows are annualized to 1984 values and that economic gains and losses are viewed from a state perspective only to reflect economic impacts on the North Dakota economy. As an example, downstream flood control or income leakages to other states are not considered in the computation of economic impacts of the project. Because of these fundamental characterisitcs of this analysis, computations are not comparable or applicable to cost-benefit analyses which take on a much broader time and geographic perspective of costs and incomes.

Inundation of rich Missouri River bottomland by Garrison and Oahe reservoirs has resulted in agricultural, mineral and forestry losses, as well as losses of recreation. It was estimated that North Dakota had annual

TABLE 11. POTENTIAL MUNICIPAL AND INDUSTRIAL USES OF GDU WATER

250,000-Acre GDU		85,510 Acre Alternative	
City	1980 Population		1980 Population
Casselton	1,661		1,661
Cogswell	227	a,b	--
Fargo	61,383	c	--
Fessenden	761	a	--
Forman	629		629
Garrison	1,830		1,830
Harvey	2,527	a,b	
Jamestown	16,280		16,280
Leeds	678		678
Mayville	2,255		2,255
McClusky	658	a	--
Mercer	134	a	--
Milnor	716		716
New Rockford	1,791		1,791
Sheyenne	307		307
Turtle Lake	707	a	--
Underwood	1,329		1,329
West Fargo	10,099	a,c	--
Sgt. County Rural	NA		--
Glenburn	454		454
Granville	281		281
Gwinner	725		725
Lakota	963		963
Lansford	294		294
Minot	32,843	c	--
Surrey	999		999
Tolna	241		241
Upham	227		227
Total	161,599		52,260

[a]Wright Water Engineers (1983) says use of surface water unaffordable for these small towns because of cost of treatment plant.
[b]Already developed alternative groundwater sources.
[c]In Hudson Bay drainage.

agricultural losses of $131 million in gross business volume and $45 million in personal income in 1984 due to the inundation from Garrison and Oahe reservoirs. In addition, annual losses in 1984 due to bank erosion were estimated at $614,500 in gross business volume and $196,300 in personal income. There were also unquantified losses of mineral resources, forest production, and wildlife.

Compensation to the state for these losses in the form of condemnation payments to landowners likely had substantial leakages outside the state

economy. Electrical power and flood control have been provided, but their magnitude has not been sufficient to compensate the state for inundation losses. Because recreation gains and losses are difficult to quantify, it is unclear if the net effect has been positive or negative.

A potential boost to the North Dakota economy is the possibility to irrigate the state's farming areas with waters diverted from Garrison Reservoir. It was estimated that irrigation of the proposed 250,000 acres of farmland in the Garrison Diversion Unit would increase annual gross business volume in North Dakota by $153 million, increase annual personal income by $50 million, and generate 3,400 jobs based on 1984 values. This increased economic activity would slightly more than compensate the state for the income flows lost due to inundation.

Additional incomes to the state are foregone each time the project is delayed. A one-year delay in water delivery from the year 1984 would cost the state $10 million in foregone gross business volume.

It is apparent that if Missouri River water resources are not developed to the benefit of agricultural, municipal, and industrial users, the state of North Dakota will have paid dearly for flood control, power, and water resource benefits that accrue to downstream states. It is fully recognized that this report takes a somewhat provincial view of Missouri Basin development. However, it is the authors' view this perspective should be considered, as policies regarding the allocation of impounded Missouri River waters are formulated. Specifically, the concept of compensation for economic losses imposed on a region or state should weigh heavily in the allocation of a resource, such as water.

APPENDIX A

Input-Output Coefficients

Gross Business Volume to Employment (Productivity) Ratios

APPENDIX TABLE A1. INTERDEPENDENCE COEFFICIENTS FOR SELECTED SECTORS, NORTH DAKOTA INPUT-OUTPUT MODEL

	(8) Retail Trade	(10) Business & Personal Service	(11d) Finance, Insurance, & Real Estate	(12) House-holds
Sector				
1. Ag, Livestock	0.0889	0.0384	0.0617	0.0674
2. Ag, Crops	0.0317	0.0152	0.3720	0.0266
3. Coal Mining	0.0000	0.0000	0.0000	0.0000
4. Contract Constr.	0.0347	0.0546	0.0728	0.0902
5. Elec. Generating	0.0000	0.0000	0.0000	0.0000
6. Pet. Exp./Ext.	0.0000	0.0000	0.0000	0.0000
7. Ag. Proc. & Misc. Mfg.	0.0452	0.0237	0.0714	0.0417
8. Retail	1.2734	0.4525	0.6761	0.7447
9. Pet. Refining	0.0000	0.0000	0.0000	0.0000
10. Bus. & Pers. Service	0.0194	1.0509	0.0766	0.0605
11. Other	0.1510	0.2846	1.3729	0.3868
12. Households	0.4034	0.7160	1.2013	1.5524
13. Government	0.0394	0.0774	0.1071	0.1080
Gross Receipts Multiplier	2.0477	2.7133	3.9048	3.0783

SOURCE: Leistritz et al., 1982.

APPENDIX TABLE A2. GROSS BUSINESS VOLUME TO EMPLOYMENT (PRODUCTIVITY) RATIOS[a], BY ECONOMIC SECTOR, 1982 (1980 = BASE DOLLARS)

Region	(1)&(2) Agric	(3) Nonmetallic Mining	(4) Const	(5) Trans	(6) Comm & Pub Util	(7) Ag Proc & Misc Mfg	(8) Retail Trade	(9) FIRE	(10) Bus & Pers Service	(11) Prof & Soc Service	(12) House-holds	(13) Govt	(14) Coal Mining	(15) Thermal-Elec Gen	(16) Pet Exp/Ext	(17) Pet Refining
	dollars															
2	63,076	--	32,763	11,677	61,163	55,066	61,657	85,257	10,537	9,269	--	5,196	--	--	217,524	--
3	67,945	116,666	42,111	14,935	115,064	57,677	117,424	131,936	18,863	16,943	--	12,584	--	--	--	--
6	75,454	122,222	41,902	14,258	76,421	57,934	91,701	101,810	18,171	11,013	--	13,296	--	--	--	--
7	63,993	--	14,901	7,038	21,975	56,083	50,112	56,605	8,305	6,592	--	6,947	65,000	294,479	185,815	1,879,452

[a]These ratios were inflated by a factor of 1.25 to represent 1984 dollars for use in this analysis.

SOURCE: Coon et al., 1984.

APPENDIX B

Inundated Land Agricultural Budgets

APPENDIX TABLE B1. BUDGET FOR A COMPOSITE ACRE OF DRYLAND INUNDATED, 1984 DOLLARS

	Wheat	Oats	Barley	Flax	Corn	Total Hay/ Alfalfa	Pasture	Fallow	Total 1984	Input Output Sector
Percent of Acre	42	12	5	4	14	11	2	10		
Yield Per Acre	28bu	50bu	40bu	11bu	45bu	2t	1.50aum			
	dollars									
Gross Income	41.04	7.92	4.44	2.87	15.75	10.92	1.79		84.73	
Seed	4.10	.96	.40	.34	2.69	.99	.08		9.56	8
Fertilizer & Chemicals	3.43	1.20	.92	.40	2.62	.25	.04		8.86	8
Miscellaneous	--	--	--	--	.56	.60	.05		1.21	10
Insurance & Interest	3.00	1.08	.43	.36	1.58	1.11	.07	.27	7.90	11d
Fuel	3.00	.85	.36	.28	1.72	1.33	.08	.44	8.06	8
Repairs	2.50	.96	.30	.32	.99	.32	.02	.15	5.56	10
Operating Capital	.88	.27	.13	.09	.58	.24	.02	.05	2.26	11d
Labor	2.39	.60	.32	.20	1.45	1.32	.11	.41	6.80	12
Depreciation	3.67	1.33	.52	.44	1.94	1.36	.09	.43	9.78	8
Returns Over Costs	18.07	0.67	1.06	0.44	1.62	3.40	1.23	-1.75	24.74	12

SOURCE: Crop rotations and yields from Leitch and Anderson (1978). Crop budgets from Farm Management Planning Guide, 1984 Crop Production Costs, Section VI, No. 1, Cooperative Extension Service, North Dakota State University, Fargo, Revised January 1984.

APPENDIX TABLE B2. BUDGET FOR A COMPOSITE ACRE OF IRRIGATED CROPLAND INUNDATED, 1984 DOLLARS

	Corn Silage	Alfalfa	Small Grain	Sugar-beets	All Beans	Pasture	Total 1984	Input-Output Sector
Percent of Acre	37	36	8	12	4	3		
Yield Per Acre	20t	4.6t	53bu	20t	22cwt	7.00aum		
	----------dollars----------							
Gross Income	121.21	82.22	14.80	71.40	15.62	6.16	311.41	
Seed	11.26	1.94	.46	1.80	1.56	.21	17.23	8
Fertilizer & Chemicals	22.61	8.04	3.24	13.42	1.97	.45	48.73	8
Miscellaneous	4.19	5.21	--	1.93	.22	.07	11.62	10
Electricity	9.10	10.71	.59	2.95	.93	.16	24.44	8
Insurance & Interest	11.89	9.17	2.55	2.39	1.25	.04	27.29	11d
Fuel	5.81	4.59	1.22	8.28	.43	1.08	21.41	8
Repairs	5.13	6.31	.35	1.61	.41	.13	13.94	10
Operating Capital	3.92	2.48	.40	2.06	.31	.14	9.31	11d
Labor	7.80	6.34	1.19	7.14	.42	.28	23.17	12
Depreciation	17.98	15.91	2.66	5.91	1.89	1.19	45.54	8
Returns Over Costs	21.52	11.52	2.14	23.91	7.23	2.41	68.73	12

SOURCE: Crop rotations and yields from survey of 200+ irrigators (45,000 acres) in Morton, Mercer, McLean, Oliver, Burleigh, McKenzie, and Emmons counties (Leitch and Anderson 1978). Crop budgets from Farm Management Guide, Crop Selection Under Irrigation in North Dakota, 1984, Section VI, No. 9, Cooperative Extension Service, North Dakota State University, Fargo, revised March 1984.

APPENDIX TABLE B3. POTENTIAL SECONDARY IMPACTS FROM IRRIGABLE LANDS INUNDATED, 1984 DOLLARS

Direct Expenditure/ Receipt by Farm Operator	First Round Expenditure Sector: Retail Trade (8) ($157.35)	Business & Per. Services (10) ($25.56)	Finance, Ins., & Real Est. (11d) ($36.60)	Households (12) ($91.90)	GBV/Acre	Total Employment[a]
Secondary Impact Sectors	dollars					
1	13.98	0.98	2.26	6.19	23.41	23
2	4.98	0.39	13.62	2.44	21.43	21
3	0	0	0	0	0	0
4	5.46	1.40	2.66	8.29	17.81	76
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	7.11	0.61	2.61	3.83	14.16	16
8	200.24	11.57	35.73	68.44	315.98	399
9	0	0	0	0	0	0
10	3.05	26.86	2.80	5.56	38.27	292
11	23.74	7.27	50.25	35.55	116.81	130
12	63.43	18.30	43.97	142.67	268.37	0
13	6.20	1.98	3.92	9.93	22.03	201
	328.19	69.36	157.82	282.90	838.28	1,158

Garrison

$838.28 x 74,101 acres = $66,308,786 GBV
$268.37 x 74,101 acres = $21,228,335 PI

Oahe

$838.28 x 15,342 acres = $12,860,892 GBV
$268.37 x 15,342 acres = $ 4,117,332 PI

[a]Total employment is that supported by 74,101 acres inundated by Garrison reservoir plus 15,342 acres inundated in North Dakota by Oahe reservoir.

APPENDIX TABLE B4. POTENTIAL SECONDARY IMPACTS FROM DRY CROPLAND INUNDATED, 1984 DOLLARS

Direct Expenditure/ Receipt by Farm Operator	First Round Expenditure Sector: Retail Trade (8) ($36.26)	Business & Per. Services (10) ($6.77)	Finance, Ins., & Real Est. (11d) ($10.16)	Households (12) ($31.54)	GBV/Acre	Total Employment[a]
Secondary Impact Sectors	---dollars---					
1	3.22	0.26	0.63	2.13	6.24	12.53
2	1.15	0.10	3.78	0.84	5.87	11.79
3	0	0	0	0	0	0
4	1.26	0.37	0.74	2.84	5.21	44.94
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	1.64	0.16	0.73	1.32	3.85	8.82
8	46.17	3.06	6.87	23.49	79.59	204.15
9	0	0	0	0	0	0
10	0.70	7.13	0.78	1.91	10.52	162.82
11	5.48	1.93	13.95	12.20	33.56	654.38
12	14.63	4.85	12.21	48.96	80.65	0
13	1.43	0.52	1.09	3.41	6.45	119.34
					231.94	1218.77

Garrison

$231.94 x 128,536 acres = $29,812,640 GBV
$ 80.65 x 128,536 acres = $10,336,428 PI

Oahe

$231.94 x 25,376 acres = $5,885,709 GBV
$ 80.65 x 25,376 acres = $2,046,574 PI

[a]Total employment is that supported by 128,536 acres inundated by Garrison reservoir plus 25,376 acres inundated in North Dakota by Oahe reservoir.

APPENDIX TABLE B5. POTENTIAL SECONDARY IMPACTS FROM PASTURE INUNDATED, 1984 DOLLARS[a]

Direct Expenditure/ Receipt by Farm Operator	First Round Expenditure Sector: Retail Trade (8) ($6.07)	Business & Per. Services (10) ($0.22)	Households (12) ($20.48)	GBV/Acre	Total Employment[b]
Secondary Impact Sectors	---dollars---				
1	0.54	0.01	1.38	1.93	5
2	0.19	0	0.54	0.73	2
3	0	0	0	0	0
4	0.21	0.01	1.85	2.07	25
5	0	0	0	0	0
6	0	0	0	0	0
7	0.27	0.01	0.85	1.13	3
8	7.73	0.10	15.25	23.08	83
9	0	0	0	0	0
10	0.12	0.23	1.24	1.59	34
11	0.92	0.06	7.92	8.80	29
12	2.45	0.16	31.79	34.40	0
13	0.24	0.02	2.21	2.47	65
				76.30	246

Garrison

$76.30 x 163,556 acres = $12,479,323 GBV
$34.40 x 163,556 acres = $ 5,626,326 PI

Oahe

$76.30 x 48,161 acres = $3,674,684 GBV
$34.40 x 48,161 acres = $1,656,738 PI

[a]1977 values from Leitch and Anderson (1978) were indexed to 1984 by a factor of 1.58.
[b]Total employment is that supported by 163,556 acres inundated by Garrison reservoir plus 48,161 acres inundated in North Dakota by Oahe reservoir.

Appendix C

Southern GDU Project Area
Agricultural Budgets

APPENDIX TABLE C1. BUDGET FOR A COMPOSITE ACRE OF DRY CROPLAND, SOUTHERN GDU AREA, 1984 DOLLARS

	Corn	Barley	Oats	Wheat	Flax	Rye	Alfalfa	Native Hay	Sunflower	Fallow	Total 1984	Input-Output Sector
Percent of Acre	14	8	5	25	5	7	6	8	12	10		
Yield Per Acre[a]	43bu	23bu	30bu	14bu	7.2bu	20bu	2.20t	1.00t	6.53cwt			
	dollars											
Gross Income	15.05	4.08	1.98	12.22	2.35	3.04	6.55	1.31	8.58		55.16	
Seed	2.29	.54	.34	2.06	.36	.29	.54	--	.86	--	7.28	8
Fertilizer & Chemicals	3.78	.66	.30	3.33	.53	.31	.70	.16	1.99	--	11.76	8
Miscellaneous	.48	--	--	--	--	--	.28	.19	1.01	--	1.96	10
Insurance & Interest	1.57	.62	.39	2.10	.33	2.01	.57	.28	1.01	.27	9.15	11d
Fuel	1.53	.56	.34	1.97	.25	.77	.67	.36	.86	.44	7.75	8
Repairs	.94	.46	.29	1.62	.23	.18	.17	.10	.60	.15	4.74	10
Operating Capital	.61	.15	.09	.61	.09	.10	.16	.05	.36	.06	2.28	11d
Labor	1.15	.42	.25	1.48	.21	.59	.65	.48	.60	.41	6.24	12
Depreciation	1.91	.76	.47	2.57	.41	1.25	.70	.34	1.24	.43	10.08	8
Returns Over Cost	0.79	-0.09	-0.47	-3.52	-0.06	-2.46	2.11	-0.65	0.05	-1.76	-6.08	12

[a]Used "MIP" budget for southern area under normal management for 20 percent loam and 80 percent sandy loam.

SOURCE: Marketing Irrigation Production, "MIP" Report No. 2. North Dakota State University, Fargo, June 1975, and Farm Management Planning Guide, Section VI: No. 9, revised March 1984, Cooperative Extension Service, North Dakota State University, Fargo.

APPENDIX TABLE C2. BUDGET FOR A COMPOSITE ACRE OF IRRIGATED CROPLAND, SOUTHERN GDU AREA, 1984 DOLLARS

	Corn	Alfalfa	Small Grain	Pinto Beans	Soy-Beans	Sun-flower	Potatoes	Total 1984	Added Dollar Flows[a]	Input Output Sector
Percent of Acre	50	12	8	6	5					
Yield/Acre	120bu	4t	48bu	22.4cwt	40bu	21.6cwt	280cwt			
	----------dollars----------									
Gross Income	150.00	23.83	13.40	23.86	12.44	21.29	109.48	354.30		
Electricity	12.30	3.57	1.86	1.39	1.16	2.21	2.46	24.95	24.95	8
Seed	20.80	.65	.50	2.34	.78	.76	9.43	35.26	27.98	8
Fertilizer & Chemicals	28.12	2.38	2.83	1.45	1.27	3.78	9.12	48.95	37.19	8
Miscellaneous	25.79	1.93	--	.33	.43	1.24	1.24	30.96	29.00	10
Insurance & Interest	16.09	3.40	.57	1.88	1.31	2.54	3.59	29.38	20.23	11d
Fuel	5.80	1.53	2.20	.64	.51	.61	6.67	17.96	10.21	8
Repairs	5.94	2.10	.35	.61	.52	.81	1.06	11.39	6.65	10
Operating Capital	5.84	.58	.40	.36	.24	.49	1.86	9.77	7.49	11d
Labor	6.28	2.11	1.06	.63	.45	.66	4.99	16.18	9.94	12
Depreciation	24.66	5.30	4.16	2.84	1.99	3.80	8.58	51.33	41.25	8
Returns Over Cost	-1.62	0.28	-0.53	11.39	3.78	4.39	60.48	78.17	84.25	12

[a]Added dollar flows represent direct expenditures or net returns of the farm operator above what would occur on dry cropland (Appendix Table C1).

SOURCE: Crop rotations and yields from survey of 21 irrigators (5,528 acres) in Stutsman, LaMoure, Dickey, and Sargent counties (Leitch and Anderson 1978), and Farm Management Planning Guide, Section VI: No. 9, revised March 1984, Cooperative Extension Service, North Dakota State University, Fargo.

APPENDIX TABLE C3. ADDITIONAL ANNUAL BUSINESS VOLUMES PER ACRE WITH PROJECT, SOUTHERN GDU AREA

Direct Expenditure/ Receipt by Farm Operator	First Round Expenditure Sector				
	Retail Trade (8)	Business & Per. Services (10)	Finance, Ins. & Real Estate (11d)	Households (12)	
	($141.58)	($35.65)	($27.72)	($94.19)	
Secondary Impact Sectors					GBV/Acre
	dollars				
1	12.59	1.37	1.71	6.35	22.02
2	4.49	.54	10.31	2.51	17.85
3	--	--	--	--	--
4	4.91	1.95	2.02	8.50	17.38
5	--	--	--	--	--
6	--	--	--	--	--
7	6.40	.84	1.98	3.93	13.15
8	180.29	16.13	18.74	70.14	285.30
9	--	--	--	--	--
10	2.75	37.46	2.12	5.70	48.03
11	21.38	10.15	38.06	36.43	106.02
12	57.11	25.53	33.30	146.22	262.16
13	5.58	2.76	2.97	10.17	21.48
GBV	295.50	96.73	111.21	289.95	793.39

APPENDIX TABLE C4. SOUTHERN GDU AREA[a] GBV AND EMPLOYMENT, 59,330 ACRES

Sector	GBV/Acre	Total GBV	Employment[b]
	----------dollars----------		
1	22.02	1,306,447	14
2	17.85	1,059,040	11
3	--	--	--
4	17.38	1,031,155	20
5	--	--	--
6	--	--	--
7	13.15	780,190	11
8	285.30	16,926,849	148
9	--	--	--
10	48.03	2,849,620	125
11	106.02	6,290,167	457
12	262.16	15,553,953	--
13	21.48	1,274,408	77
	793.39	47,071,829	863

[a]State Region 6.
[b]Coon et al., p. 56.

Appendix D

Central GDU Project Area
Agricultural Budgets

APPENDIX TABLE D1. BUDGET FOR A COMPOSITE ACRE OF DRY CROPLAND, CENTRAL GDU AREA, 1984 DOLLARS

	Corn	Barley	Oats	Wheat	Flax	Rye	Alfalfa	Native Hay	Sunflower	Fallow	Total 1984	Input-Output Sector
Percent of Acre	5	9	7	38	4	3	8	7	4	15		
Yield Per Acre[a]	6.4bu	21bu	27bu	15bu	7.3bu	15bu	1.72t	.48t	5.92cwt			
	dollars											
Gross Income	5.24	4.20	2.49	19.89	1.90	.98	6.83	1.17	2.59		45.29	
Seed	.60	.43	.35	2.04	.24	.11	.73	--	.19		4.69	8
Fertilizer & Chemicals	.67	.71	.29	3.95	.23	.13	.57	--	.60		7.15	8
Miscellaneous	--	--	--	--	--	--	.30	.09	.20		.59	10
Insurance & Interest	.50	.70	.54	3.19	.27	.27	1.17	.06	.34	.52	7.56	11d
Fuel	.51	.63	.47	2.99	.20	.39	1.00	.22	.29	.67	7.37	8
Repairs	.26	.52	.41	2.46	.18	.07	.25	.02	.20	.22	4.59	10
Operating Capital	.14	.15	.10	.63	.06	.05	.19	.02	.10	.09	1.53	11d
Labor	.69	.47	.35	2.24	.17	.35	1.02	.28	.20	.61	6.38	12
Depreciation	.61	.85	.67	3.90	.33	.33	1.43	.07	.41	.64	9.24	8
Returns Over Cost	1.26	-.26	-.69	-1.51	.22	-.72	0.17	0.41	-.26	-2.43	-3.81	12

[a]Used "MIP" budget for central area under normal management for 23 percent loam and 77 percent sandy loam. Marketing Irrigation Production, "MIP" Report No. 2, June 1975, pp. 69-72.

APPENDIX TABLE D2. BUDGET FOR A COMPOSITE ACRE OF IRRIGATED CROPLAND, CENTRAL GDU AREA, 1984 DOLLARS

	Corn	Alfalfa	Pinto Beans	Flax	Small Grain	Sun-flower	Potatoes	Total 1984	Added Dollar Flows[a]	Input Output Sector
Percent of Acre	24	19	6	4	22	20	5			
Yield/Acre	15t	4.6t	21.6cwt	23bu	53bu	19.2cwt	280cwt			
	dollars									
Gross Income	58.97	43.39	23.00	6.00	40.69	42.05	54.74	268.84	223.55	
Seed	11.07	4.34	1.45	.16	8.92	7.46	4.56	37.96	30.81	8
Fertilizer & Chemicals	3.02	3.06	.33	--	--	4.08	.62	11.11	10.52	10
Miscellaneous	5.90	5.65	1.39	.30	1.65	4.92	1.15	20.96	20.96	8
Electricity	8.11	1.03	2.34	.25	1.28	1.68	4.72	19.41	14.72	8
Insurance & Interest	8.57	5.38	1.88	1.16	7.02	5.65	1.80	31.46	23.90	11d
Fuel	4.19	2.42	.64	.53	3.34	1.35	3.34	15.81	8.44	8
Repairs	3.32	3.33	.61	.17	.98	1.79	.53	10.73	6.14	10
Operating Capital	2.40	1.34	.46	.10	1.09	1.44	1.01	7.84	6.31	11d
Labor	5.06	3.35	.63	.50	3.30	1.48	2.50	16.82	10.44	12
Depreciation	12.96	8.40	2.84	1.28	7.31	8.44	4.29	45.52	36.28	8
Returns Over Cost	-5.63	5.09	10.43	1.55	5.80	3.76	30.22	51.22	55.03	12

SOURCE: Crop rotations and yield from survey of 30 irrigators (7,817 acres) in Foster, Wells, Benson, Sheridan, Nelson, and Eddy counties, 1977, (Leitch and Anderson 1978). Crop budgets from Farm Management Planning Guide, Crop Selection Under Irrigation, 1984, Section 6, No. 9, Cooperative Extension Service, North Dakota State University, revised March 1984.

APPENDIX TABLE D3. ADDITIONAL ANNUAL BUSINESS VOLUMES PER ACRE WITH PROJECT, CENTRAL GDU AREA, 1984 DOLLARS

Direct Expenditure/ Receipt by Farm Operator	First Round Expenditure Sector				
	Retail Trade (8)	Business & Per. Services (10)	Finance, Ins. & Real Estate (11d)	Households (12)	
	($111.21)	($16.66)	($30.21)	($65.47)	
Secondary Impact Sectors					GBV/Acre
	dollars				
1	9.89	.64	1.86	4.41	16.80
2	3.53	.25	11.24	1.74	16.76
3	--	--	--	--	--
4	3.86	.91	2.20	5.91	12.88
5	--	--	--	--	--
6	--	--	--	--	--
7	5.03	.39	2.16	2.73	10.31
8	141.61	7.54	20.42	48.76	218.33
9	--	--	--	--	--
10	2.16	17.51	2.31	3.96	25.94
11	16.79	4.74	41.48	25.32	88.33
12	44.86	11.93	36.29	101.64	194.72
13	4.38	1.29	3.24	7.07	15.98
GBV	232.11	45.20	121.20	201.54	600.05

APPENDIX TABLE D4. CENTRAL GDU AREA[a] GBV AND EMPLOYMENT, 74,670 ACRES

Sector	Total GBV	Sector Area Total	Employment[b]
	----------dollars----------		
1	16.80	1,254,456	13
2	16.76	1,251,469	13
3	--	--	--
4	12.88	961,750	18
5	--	--	--
6	--	--	--
7	10.31	769,848	11
8	218.33	16,302,701	142
9	--	--	--
10	25.94	1,936,940	85
11	88.33	6,595,601	479
12	194.72	14,539,742	--
13	15.98	1,193,227	72
	600.05	44,805,734	833

[a]State Region 6.
[b]Coon et al., 1984, p. 56.

APPENDIX TABLE D5. POTENTIAL SECONDARY IMPACTS FROM PROJECT FEATURE DRY CROPLAND, 1984 DOLLARS

	First Round Expenditure Sector					
	Retail Trade (8)	Business & Per. Services (10)	Finance, Ins. & Real Estate (11d)	Households (12)		
Direct Expenditure/ Receipt by Farm Operator	($28.45)	($4.69)	($9.09)	($2.57)		
Secondary Impact Sectors					GBV/Acre	Employment
	dollars					
1	2.53	0.18	0.56	0.17	3.44	1
2	0.92	0.07	3.38	0.07	4.44	1
3	0	0	0	0	--	-
4	0.99	0.26	0.66	0.23	2.14	2
5	0	0	0	0	--	-
6	0	0	0	0	--	-
7	1.29	0.11	0.65	0.11	2.16	1
8	36.23	2.12	6.60	1.91	46.86	16
9	0	0	0	0	--	-
10	0.55	4.93	0.75	0.16	7.39	10
11	4.30	1.33	13.41	0.99	21.35	5
12	11.48	3.36	11.73	3.99	30.56	-
13	1.12	0.36	1.05	0.28	2.81	5
					121.15	41

Appendix E

Northern GDU Project Area
Agricultural Budget

APPENDIX TABLE E1. BUDGET FOR COMPOSITE ACRE OF DRY CROPLAND, NORTHERN GDU AREA, 1984 DOLLARS

	Corn	Barley	Oats	Wheat	Flax	Rye	Alfalfa	Native Hay	Fallow	Total 1984	Input-Output Sector
Percent of Acre	5	5	9	25	8	3	15	10	20		
Yield Per Acre[a]	38bu	21bu	27bu	15bu	7.3bu	15bu	1.7t	0.5t			
	dollars										
Gross Income	4.75	2.33	3.21	13.09	3.81	0.98	12.81	1.67		42.65	
Seed	.78	.40	.72	2.42	.68	.16	.66	--		5.82	8
Fertilizer & Chemicals	.50	.45	.50	1.53	.32	.15	1.20	--		4.65	8
Miscellaneous	--	--	--	--	--	--	.67	.15		0.82	10
Insurance & Interest	.64	.43	.75	1.84	.72	.45	2.30	.16	.91	8.20	11d
Fuel	.47	.33	.54	1.58	.48	.23	1.11	.18	.53	5.45	8
Repairs	.26	.28	.61	1.30	.55	.07	.52	.04	.32	3.95	10
Operating Capital	.14	.10	.16	.46	.14	.03	.28	.02	.05	1.38	11d
Labor	.72	.33	.55	1.51	.40	.27	1.47	.30	.63	6.18	12
Depreciation	.79	.52	.92	2.25	.88	.62	2.81	.19	1.62	10.60	8
Returns Over Cost	0.45	-0.51	-1.54	0.20	-0.36	-1.00	1.79	0.63	-4.06	-4.40	12

[a]Used "MIP" budget for northern area under normal management for 20 percent loam and 80 percent sandy loam.

SOURCE: Marketing Irrigation Production, "MIP" Report No. 2. North Dakota State University, Fargo, June 1975.

APPENDIX TABLE E2. BUDGET FOR A COMPOSITE ACRE OF IRRIGATED CROPLAND, NORTHERN GDU AREA, 1984 DOLLARS

	Corn	Alfalfa	Small Grain	Potatoes	Sun-flower	Pinto Beans	Total 1984	Added Dollar Flows[a]	Input Output Sector
Percent of Acre	34	46	7	3	4	6			
Yield/Acre[a]	15t	4.23t	44bu	280cwt	21.6cwt	18cwt			
	----------dollars----------								
Gross Income	83.54	96.82	10.75	32.84	9.46	19.17	252.58		
Seed	7.05	2.48	.68	3.36	.34	2.11	16.02	10.20	8
Fertilizer & Chemicals	15.70	9.70	.86	3.10	2.29	1.30	32.95	28.30	8
Miscellaneous	3.05	6.29	--	.44	.74	.30	10.82	10.00	10
Electricity	7.11	11.64	.82	.70	.96	1.25	22.48	22.48	8
Insurance & Interest	10.32	11.07	3.91	1.82	1.02	1.69	29.83	21.63	11d
Fuel	5.04	4.98	.95	1.19	.27	.58	13.01	7.56	8
Repairs	4.0	6.85	.34	.35	.36	.55	12.45	8.50	10
Operating Capital	2.83	2.83	.25	.62	.33	.41	7.27	5.89	11d
Labor	7.17	8.11	.90	1.16	.30	.63	18.27	12.09	12
Depreciation	15.61	17.28	4.92	4.91	1.52	2.56	46.80	36.20	8
Returns Over Cost	5.66	15.59	-2.88	15.19	1.33	7.79	42.68	47.08	12

[a]Dollar flows with project less dollar flows without project.

SOURCE: Rotations and yields from survey of 13 irrigators (2,456 acres) in Renville, McHenry, and Bottineau counties, 1977. Crop budgets from Farm Management Planning Guide, Crop Selection Under Irrigation, 1984, Section VI, No. 9, Cooperative Extension Service, North Dakota State University, Revised March 1984.

APPENDIX TABLE E3. ADDITIONAL ANNUAL BUSINESS VOLUMES PER ACRE WITH PROJECT, NORTHERN AREA

Direct Expenditure/ Receipt by Farm Operator	First Round Expenditure Sector				
	Retail Trade (8)	Business & Per. Services (10)	Finance, Ins. & Real Estate (11d)	Households (12)	
	($104.74)	($27.52)	($18.50)	($59.17)	
Secondary Impact Sectors					GBV/Acre
	dollars				
1	9.31	1.70	0.71	3.99	15.71
2	2.27	10.24	0.28	1.57	14.36
3	0	0	0	0	0
4	3.63	2.00	1.01	5.34	11.98
5	0	0	0	0	0
6	0	0	0	0	0
7	4.73	1.96	0.44	2.47	9.60
8	133.38	18.61	8.37	44.06	204.43
9	0	0	0	0	0
10	2.03	2.11	19.44	3.58	27.16
11	15.82	37.78	5.27	22.89	81.76
12	42.25	33.06	13.25	91.86	180.42
13	4.13	2.95	1.43	6.39	14.90
GBV	217.55	110.41	50.20	182.15	560.31

APPENDIX TABLE E4. NORTHERN GDV AREA[a] GBV AND EMPLOYMENT, 116,000 ACRES

Sector	GBV/Acre	Total GBV	Employment[b]
	----------dollars----------		
1	15.71	1,822,360	23
2	14.36	1,665,760	21
3	--	--	--
4	11.98	1,389,680	34
5	--	--	--
6	--	--	--
7	9.60	1,113,600	16
8	204.42	23,712,720	308
9	--	--	--
10	27.16	3,150,560	239
11	81.76	9,484,160	818
12	180.42	20,928,720	--
13	14.90	1,728,400	266
	560.31	64,995,960	1,275

[a]State Region 2.
[b]Coon et al., p. 52.

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